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Original Article

EVALUATION OF (WHITE FLESH) SWEET POTATO (*IPOMOEA BATATAS*. L.) CULTIVARS UNDER MANIPUR CONDITION

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ABSTRACT

A field experiment was conducted at Central Agricultural University, Imphal and Manipur, during kharif season 2014, to study the growth, yield and quality of seven white flesh sweet potato, laid out in randomized block design with three replications. Among the different cultivars tested, the cultivar 40038, recorded the maximum LAI (0.95) and the tuber length of (13.00 cm). The tuber diameter (5.50 cm) was the highest in the cultivar DOP-93,19, with better sized tubers and greater tuber yield (205.56 g) in DOP- 93,19 led to the highest total yield (38.96 t ha^{-1}), closely followed by cultivar RS-92. Quality analysis, revealed IGSP-18 as the richest source of starch (21.16%), followed by C-1, while X-24 registered the maximum total sugar (2.70%) and Sree Bhadra with maximum crude protein (1.03%). The study showed that, cultivars DOP 93, 19 and RS-92, which have superior growth parameters, can be suggested for growing, under Manipur's weather condition.

KEYWORDS: Sweet Potato, Tuber Yield, Starch & Crude Protein

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INTRODUCTION

In India, majority of farmers cultivate root and tuber crops as a subsistence crop, mainly as intercrops in homestead. This crop has great potentiality to alleviate wide spread malnutrition and poverty problems in developing countries. It is a rich source of starch and vitamin A. Fresh sweet potatoes provide about 50% more calories than Irish potato (Woolfe, 1992). It plays an important role in the economy of poor households and acts as a major source of subsistence and cash income to farmers, in agro climatically disadvantageous regions (Rajib Nath et al., 2007). Sweet potato is a source of food, feed as well as processed products. This crop is well suited to small and marginal holdings, due to its flexible planting and harvesting times, low requirement of inputs and management. The growth and tuber yield of sweet potato cultivars varies with the growing season. Since, growth, tuber yield and quality are the factors affecting production; the present study was conducted to find out the adaptability of sweet potato cultivars in Manipur so as to meet the growing demand of the crop.

MATERIALS AND METHODS

White flesh cultivars of sweet potato viz., 440038, RS-92, Sree Bhadra, X-4, IGSP-18, C-1 and DOP 93-19 were grown at the experimental field of Central Agricultural University, Imphal, Manipurduring the *kharif* season 2014. The soil of this zone is clay loam in nature, with pH in the range of 5.24 to 6.14. The mean temperature in summer is 30^{o}C, with an average annual rainfall of 1212mm. The experimental site is located at

24.4848° N latitude and 93.5318° E longitude, with an elevation of 786 m MSL. The experiment was laid out in randomized block design, with three replications. Apical vine cuttings of 20 cm length were planted at a spacing of 60 x 20 cm, in plots of 2.4 x 1.4 m size, accommodating 28 plants per plot. FYM @ 12.5 t ha^{-1} and chemical fertilizers, to supply NPK @ 50:25:50 kg ha^{-1} were applied. Half N and full P and K were given as basal and the rest were applied at 30 days, after planting. Plant protection and weeding was done, as per package of practices recommendation. The observation of the yield attributing characters and total tuber yield, were recorded at harvesting (120DAP) and statistically analyzed, as per Gomez and Gomez, 1984.

The parameters recorded in the study are as follows:

Physiological Parameters

- **Leaf Area Index (LAI)**

Leaf area index is the ratio between leaf areas, to canopy of the plant. Leaf area index per plant was calculated, by using the formula expressed as follows:

$$LAI = \frac{\text{Total Leaf Area } (cm^2)}{\text{Canopy of the plant } (cm^2)}$$

- **Net Assimilation Rate (NAR) (g $m^{-2}day^{-1}$)**

It indirectly indicates the rate of net photosynthesis. It is expressed as (g) of dry matter, produced per square meter of leaf in a day. For calculating NAR, leaf area of individual plant has to be used. It was recorded by the formula given by Gregory (1926).

$$NAR = \frac{W_2-W_1}{L_2-L_1} \times \frac{\text{Log } L_2-\text{Log } L_1}{t_2-t_1} \quad g\ m^{-2}day^{-1}$$

Where, W_1 and W_2 refer to whole plant dry weight and L_1 and L_2 refer to leaf area on two successive periods at t_1 and t_2.

- **Plant Growth Efficiency (%)**

It was recorded by the given equation

$$E = \frac{D_2-D_1}{Dm} \times 100$$

Where, Dm = Maximum dry weight or dry wt. at harvest, D_1 = Dry weight of plant at $time_1$, D_2 = Dry weight of plant at $time_2$

- **Harvest Index (HI)**

Harvest index is calculated by using following formula at harvest**:**

$$\text{Harvest Index} = \frac{\text{Tuber weight}}{\text{Whole plant weight}} \times 100$$

Qualitative Traits

Tuber Dry Matter (%)

As for qualitative evaluation the dry matter (DM) content was worked out as dry weight of tubers per fresh weight x 100, dry weight of tubers was recorded as the oven dried yield at 60 ±2°C to a constant weight.

Storage Root Nitrogen (%) of Tuber

The total nitrogen content (%) of the tubers was analyzed as per Microkjeldahl's method.

Sugar Content (%) of Tuber

The total sugar content was analysed by following the Anthrone reagent method, as described by Thimmaih (2006).

Starch Content (%) of Tuber

The tuber starch content was analysed, by following the Anthrone reagent method, as described by Thimmaih (2006).

Crude Protein (%) of Tuber

Crude protein was estimated as a product of percent nitrogen, in meals extracted in 70% (V/V) ethanol X 6.25 and the amino acid composition of the protein was estimated, by analysis of the meals after extraction with ethanol, as described by Marta Evans, *et al.* (1977)

Statistical Analysis

The experimental data were analyzed statistically, by the method of analysis of variance for single factor experiment (Gomez and Gomez, 1976). The significance of the calculated variance was determined by "F" test.

In order to test the significance of mean differences between treatments, the following statistics were computed.

Standard Error of Mean Differences (S. Ed)

$$S.E = \sqrt{\frac{2xEMS}{r}}$$

Where, EMS = error mean sum of squares, r = number of replications

Critical Difference (C. D)

C. D. = *S.Ed* x t for error degrees of freedom at 5% and 1% level of probability/ significance.

RESULTS AND DISCUSSIONS

Physiological Parameters

Leaf Area Index

In the experimentations, there were significant differences of leaf area index among the treatments. The leaf area

index increased with the advancing of days and decreased at later stage of growth, which was due to the production of more number of active leaves at early stages and later decreases due to senescence, mutual shading of leaves within the canopy and decrease in growth. Among the white flesh types, the highest leaf area index was recorded with cultivar 440038 (0.95) at 100 DAT which was significantly higher than the rest of the treatments and the minimum was recorded from IGSP-18 (0.33) at 100 DAT.

This finding is in conformity with Naskar and Chowdhury (1994) and Goswami (2000).

Plant Growth Efficiency (%)

In the experiments, there were significant differences among the different treatments, in respect to plant growth efficiency (%) and showed decreasing rate of plant growth efficiency, at the time intervals from 60-80 DAT and 80-100 DAT. Among the white flesh sweet potato cultivars, plant growth efficiency was found lowest in DOP-93, 19 (15.19 %) and highest in X-24 (29.58 %), which was statistically at par with the rest of the treatments. The results in higher plant growth efficiency were due to vigorous growth of plant parts and lower plant growth efficiency, were due to lesser production of plant parts at the specific time intervals recorded. Similar observations were also reported by Ankumah *et al.* (2003).

Net Assimilation Rate (g $m^{-2}day^{-1}$)

There were significant differences among the different treatments, in respect to net assimilation rate (g $m^{-2}day^{-1}$) and showed decreasing rate of plant growth efficiency, At 100 DAT net assimilation rate was as high as 0.022 g $m^{-2}day^{-1}$, recorded from C-1 and was statistically at par with IGSP-15 and DOP-93-19 (0.019 g m^{-2} day^{-1}) and the minimum was recorded from ST-14 (0.012 g m^{-2} day^{-1}), followed by S-1156 (0.016 g m^{-2} day^{-1}). The statistical analysis of net assimilation rate, indicated no significant difference among the treatments. The cultivars showed decreased NAR at 100 DAT, which might be due to mutual shading of leaves within the canopy, as reported by Huett and O'Neill (1976) and Tsuno and Fujise (1965). The higher rate of NAR at early stages may be, due to rapid increase of dry matter in the vine and tubers of the cultivars, which was also reported by Mannan *et al.* (1992).

The data on harvest index (%) at harvesting revealed that there was significant effect of cultivars tested.

Harvest Index

In the experiment white flesh sweet potato cultivars, the maximum harvest index was recorded from DOP 93, 19 (29.00 %), which was significantly higher than the rest of the treatments and the minimum harvest index was recorded from 440038 (16.05 %). The high harvest index obtained in the mentioned treatments is due to high tuber yield. This result was in conformity with the findings of Bhagsari and Ashley (1990).

Yield and Yielding Parameters

Data on yield and yielding parameters at different stages of observation revealed that there were significant differences among the different treatments. At harvest the maximum tuber diameter (5.50 cm) was recorded from the treatment DOP-93, 19, which was at par with Sree Bhadra (5.17 cm), C-1 (4.96 cm), RS-92 (4.60 cm) and 440038 (4.45 cm), whereas the minimum tuber diameter was recorded in cultivar X-24 (3.63 cm) and the maximum tuber length (13.00 cm) was recorded from the treatment 440038 and there was no significant difference among the treatments. The highest number of tubers per plant was recorded at harvesting from RS-92 (3.97) which, however, was statistically at par with Sree Bhadra (3.80) and the lowest number of tubers per plant was recorded from DOP-93,19 (2.27). Single tuber weight was as high as 205.56 g in

DOP 93, 19, followed by RS-92 (102.30 g) and the minimum (58.97 g) was recorded in X-24. The highest tuber yield per plant was also recorded from DOP-93, 19 (466.97 g) which was significantly higher than the rest of the treatments, followed by RS-92 (405.97 g) and the minimum was obtained from X-24 (172.95 g). The highest tuber yield per hectare was recorded from DOP 93, 19 (38.96 t ha^{-1}), followed by RS-92 (33.87 t ha^{-1}). The minimum tuber yield was obtained in X-24 (14.43 t ha^{-1}). This result was in conformity with the findings of Sarkar *et al.* (1992), Shirke *et al.* (2002) and Gin *et al*. (2008), in sweet potato. Due to the increase in different plant characters like number of active leaves, leaf area and vine length, which caused increase in photosynthetic rate and vegetative growth of the plant. The magnificent increase in the yield might be attributed to the high resume of carbohydrate and large leaf area, for better exposure to available sunlight. The increase in the number of tuber per plant has a direct and positive effect, on yield of sweet potato (Chen *et al*., 1995). Similar results were reported in cassava (*Manihot esculenta* Crantz), by Balakrisnan and Thamburaj (1993).

Tuber Quality Parameters

From the study of quality parameters, among the white flesh sweet potatoes it was observed that, tuber dry matter (%) was the maximum in cultivar 440038 (29.78 %), which was significantly higher than the rest of the treatments and was followed by DOP-93,19 (25.54 %), and the minimum tuber dry matter (18.60 %) was recorded in C-1. The storage root nitrogen content was, as high as 1.03% in the cultivar Sree Bhadra, followed by RS-92 (0.87 %). The crude protein content was the maximum (6.46 %) in Sree Bhadra tubers, followed by RS-92 (5.42 %). The highest starch content was recorded in IGSP-18 (21.16 %) and was statistically at par with C-1 (19.59 %) and the minimum was recorded in X-24 (14.23 %). The sugar content of tuber was the highest in X-24 (2.70 %) which and was statistically at par with the rest of the treatments except for C-1 (1.72 %) and 440038 (1.85 %) which recorded the minimum sugar content among the cultivars tested. This result was in conformity with the findings of Padmaja *et al.* (2005), Chattopadhyay *et al.* (2002) and Saikia *et al.* (2009). The dry matter of sweet potato tuber, ranged from 19.9 to 45.4% and the fresh weight basis starch content, ranged from 11.1 to 33.5% (Brabet *et al*., 1998) and the fresh weight basis sugar content, ranged from 1.64 to 4.46 %, as reported by Chattopadhyay *et al.*, 2002).

CONCLUSIONS

From the studies, it can be concluded that, DOP 93, 19 and RS-92for white flesh sweet potato, which have high tuber yield per hectare and with desirable tuber quality, can be grown under Manipur condition.

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Table1. Physiological Parameters of white Flesh Sweet Potato Cultivars at 100 DAP and Harvest index at 120 DAP

Treatments	Leaf Area Index (LAI)	Plant Growth Efficiency (%)	Net assimilation Rate (g $m^{-2}day^{-1}$)
440038	0.95	18.75	0.012
RS-92	0.46	17.64	0.016
Sree Bhadra	0.37	17.81	0.018
X-4	0.37	19.14	0.017
IGSP-18	0.33	17.23	0.019
C-1	0.64	16.05	0.022
DOP 93-19	0.47	15.19	0.019
440038	0.05	1.57	0.002

Table 1: contd.,			
C. D 0.05	0.12	3.42	0.004

Table 2: Study on Quality Parameters of Orange Flesh Sweet Potato Cultivars

Treatments	Dry Matter %	Storage Root Nitrogen % (Dry Weight Basis)	Starch Content % (Fresh Weight Basis)	Sugar Content % (Fresh Weight Basis)	Crude Protein % (Dry Weight Basis)
440038	29.78	0.77	17.37	1.85	4.79
RS-92	22.04	0.87	15.54	2.18	5.42
Sree Bhadra	24.29	1.03	16.49	2.46	6.46
X-4	27.08	0.83	14.23	2.70	5.21
IGSP-18	22.71	0.83	21.16	2.20	5.21
C-1	18.60	0.77	19.59	1.72	4.79
DOP 93-19	25.54	0.73	18.56	2.58	4.58
440038	0.92	0.07	0.54	0.31	0.26
C.D 0.05	2.00	0.15	1.77	0.68	0.56

Table3: Yield and Yielding Parameters of Orange Flesh Sweet Potato Cultivars at Harvest (120 DAP)

Treatments	Tuber Diameter (cm)	Tuber Length (cm)	No. of Tubers per Plant	Single Tuber Weight (g)	Tuber Yield per Plant (g)	Tuber Yield (tha^{-1})	Harvest Index at 120 DAT
440038	4.45	13.00	3.20	65.03	208.12	17.37	16.05
RS-92	4.60	10.83	3.97	102.30	405.97	33.87	19.60
Sree Bhadra	5.17	11.17	3.80	94.47	359.03	29.96	22.59
X-4	3.63	12.00	2.93	58.97	172.95	14.43	17.43
IGSP-18	4.10	12.67	3.00	81.03	244.87	20.43	20.00
C-1	4.96	11.76	3.33	87.33	291.10	24.29	16.91
DOP 93-19	5.50	11.64	2.27	205.56	466.97	38.96	29.00
SE (d)	0.57	1.10	0.29	4.19	25.42	2.12	1.02
C.D 0.05	1.24	1.27	0.59	25.32	126.53	632.81	2.32